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THE MEASUREMENT OF THE ICC OF THE 192 keV TRANSITION IN In-114m.

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ABSTRACT. A method employing internal-external-conversion technique using a well-type plastic scientillation spectrometer (Raja Rao and Jnanananda, 1965) is adapted for the measurement of the ICC for the 192 keV transition in In-114m with foils of Ta and Cd as external converters. The average value obtained for the deduced $\alpha_k = 1.95 \pm 0.29$ which is compared with the theoretical values of Rose and Sliv.

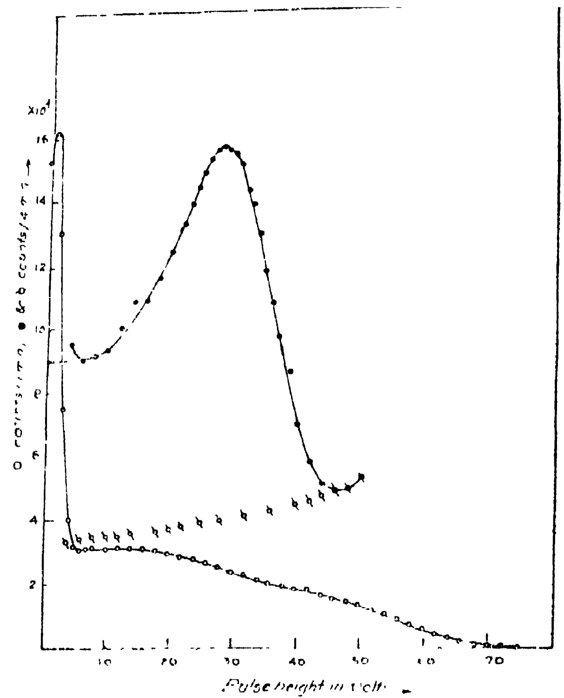
INTRODUCTION

Measurements of Steffen (1951) have shown that for α_k values the multipole assignment for this 192 keV transition could be E4 while for K/L ratio the assignment could be E5. This discrepancy had been resolved by other measurements (Grabowski *et al*, 1962, Daniel *et al*, 1963 and Kleinheinz *et al*., 1964) on K/L ratio which support the E4 assignment. However, the K/M, $K/M+N$ and $K/L+M+N$ ratios as determined by a precision method (Daniel *et al*., 1963) are found to be considerably higher than the theoretical computed values. Therefore a remeasurement of α_k, possibly with a different technique, serves as a check in establishing the multipole assignment. The present internal-external-conversion technique employing a beta scintillation spectrometer enables an independent measurement of the total ICC, α. The multipole assignment is fixed on comparing the deduced α_k value with the theoretical values (Sliv and Band, 1965, Rose 1958).

EXPERIMENTAL

The In-114m isotope, having a half-life of 50 days, is obtained in liquid form with an activity of 1.5 mC/ml from the Atomic Energy Est., Trombay. The source is spread over a circular area of diameter ~5mm on a thin alkathene film of thickness ~2mg/cm^2. On evaporation the source thickness is ~ 200 micro gms/cm^2. The mounting of the source, the collimator, the geometry and the rest of the experimental arrangements are described in the author's earlier paper (Raja Rao and Jnanananda, 1965) in which the experimental procedure also is described in detail.

The observed electron spectra for low gain and high gain adjustments of the amplifier are plotted as shown in Fig. 1. In order to arrive at the value of the intensity of the conversion electrons (whose average energy indicated by the peak being 175 keV), the underlying beta continuum had to be subtracted. The spectral



Pulse height in volts.

Fig. 1. Beta and conversion electron spectra of In-114m source. The points o represent the total spectrum for low gain of the amplifier. The points represent the conversion electrons at high gain. The points ᴓ represent the extrapolated beta spectrum obtained from Fig. 2.

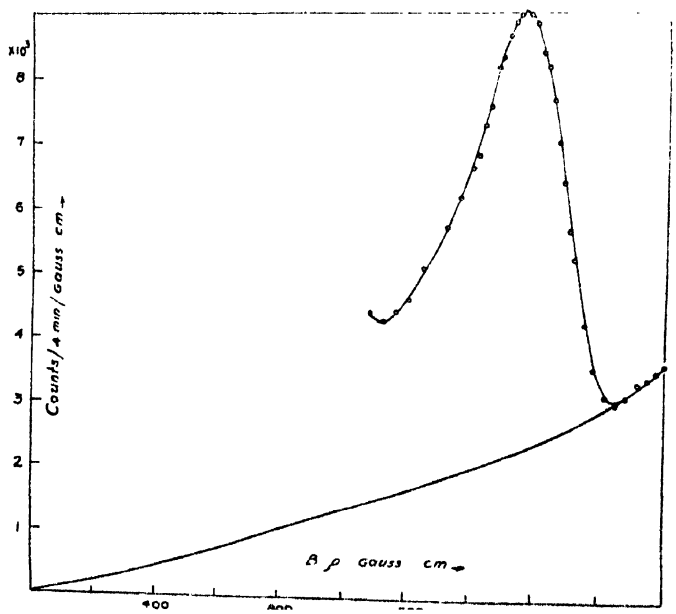


Fig. 2. Beta spectrum of In-114m source translated into momentum distribution. The recorded spectrum is represented by 0 and the continuous line is the extrapolation to the origin.

shape of the continuum in the low energy region is found by the following method: The observed spectrum is transferred into that of a momentum distribution, i.e., $B\rho$ vs counting rate per unit $B\rho$, employing published tables (Gerholm, 1955), as shown in Fig. 2. Assuming that in such a momentum distribution a beta continuum starts from the origin, the observed continuum is smoothly joined to the origin. This extrapolated part, on transformation back into the corresponding counts/channel width in the energy scale and then again into the pulse height in volts vs counts/ channel width, indicates the spectral shape of the continuum in the low energy region as shown in Fig. 1. The observed conversion line, area (a_e), occupied by the conversion peak, is measrured twice on different days A and B as 69.6 cm^2 and 69.1 cm^2 respectively when plotted to a scale of 5 volts/cm on the X-axis (X_e) and 10^4c/4 min/cm on the Y-axis (Y_e). These values of a_e are corrected (ref. 7) employing the factors (i) for geometry, $f_g = G_r/G_e = 0.0053/0.0038$, (ii) for air +window absorption, $f_w = 1.18$ and (iii) for phosphor-back-scattering of electron, $f_{pb} = 1.365$. The values for the true conversion electron intensity per min. $N_e = a_e X_e Y_e f_g f_w f_{pb}$ for A and B are 19.495×10^5 and 19.362×10^5 respectively. In view of the above mentioned extrapolation and the small inaccuracies in the corrections as well as the negligence of other not very significant corrections at this energy region, the N_e values are accurate limited to an estimated error of 10%.

Gamma ray measurement is made by recording the photoelectron liberated, on external conversion, in foils of tantalum (8.73 mg/cm^2) and cadmium (11.97

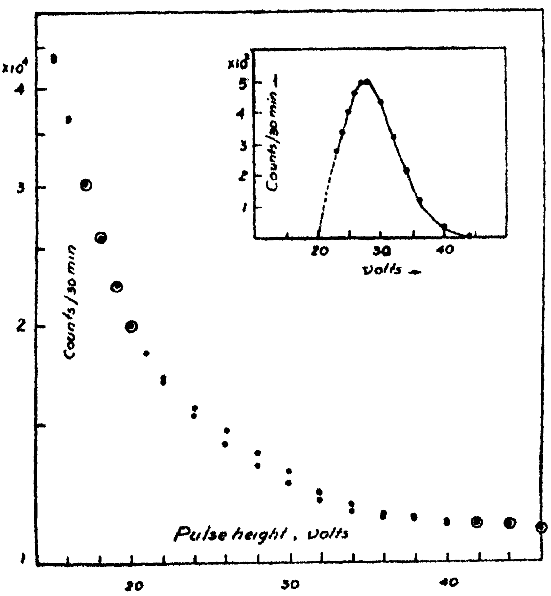


Fig. 3. Gamma spectra of In-114m source. The points o represent the spectrum with a Cd external converter and the points ● that with the compton-equivalent Al target. The insert shows the photoelectron distribution.

mg/cm^2) of diameter 1.039 cm. after having stopped all the beta groups from entering the detector with a suitably thick *Al* stopper. The converter is located inside the well of the phosphor as described in a previous paper (Raja Rao *et al.* 1965). The observed spectra with the cadmium converter and a compton equivalent aluminium target as well as the resulting photoelectrons pectrum are shown in Fig. 3. The photoelectron line area (a_p) as measured on the plots scaled to 5 volts/cm (X_p) and 100c/30min/cm (Y_p) are obtained as 25.1 cm^2 (Ta, A) and 10.89 cm^2(Cd, B). The corresponding values for gamma intensity $N_r = a_p X_p Y_p f_{Al} f_{ad} f_{sa} f_{pb} / \sigma N$ are obtained applying the factors for (i) the gamma ray attenuation in the Al stopper $f_{Al} = 1.131$, (ii) the angular distribution of the emitted photoelectrons $f_{ad} = 1.075$, (iii) the absrorption of photoelectrons within the converter $f_{sa} = 3.09$ (*Ta*) and 3.094 (Cd) and (iv) for the phosphor backscattering of the photoelectrons $f_{pb} = 1.516$ (Ta) and 1.389 (Cd). The values for N_r per min are obtained as 4.718×10^5(A) and 4.587×10^5(B) on substituting the values 205 (Ta) and 38 bn/atom (Cd) for the photoelectric cross-section σ (Grodstein, 1953), and for N, the number of atoms in the converter. The error in the N_r value is estimated to be 10% because of the small inaccuracies in the several factors involved and also in view of the negligence of the coherent and bound electron scattering effects.

TABLE I

Trial	Convertor	Total ICC $\alpha = N_e/N_r$	Average α	Accepted K/L (ref. 1, 2)	Exptl. α_k $\alpha/(1+\frac{4}{3}L/K)$	Theor. α_k for E4 Rose Sliv	Other exptl. α values
I	Ta	4.132	4.176 $\pm$0.044	1.16	1.94$\pm$0.29	2.5 2.25	4.2$\pm$0.4 (ref. 3)
	Cd	4.22					4.0 (ref. 4)
II	Ta	4.164	4.211 $\pm$0.047		1.96$\pm$0.29		4.3$\pm$0.04 (ref. 5)
	Cd	2.58					

1. Grabowski et.al., 1962
2. Kleinheinz et.al., 1964
3. Steffen, 1951
4. Boehm et.al., 1949
5. Hoffman, 1957.

The present values of conversion coefficients (α and α_k) along with the theoretical *K*-conversion coefficients are presented in Table I. The deduced α_k expt. values in the table are limited in accuracy having a total error of 15%. As can be seen the α_k values are in agreement with Sliv's theoretical value for 192 keV E4 radiation.

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